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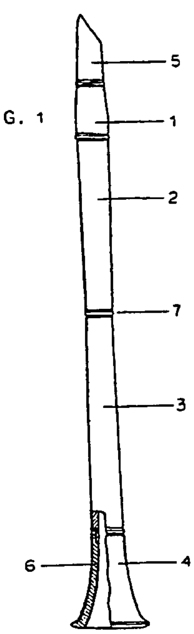
(54) **Musical instruments comprising ceramic-resin composites.**

(57) A musical instrument improved in sound tones and other properties is provided, the instrument body of which comprises a machinable ceramic-resin composite material. The instruments can be readily produced by a method which comprises impregnating a machinable ceramic article containing substantially continuous micro-pores with a liquid resin material and hardening the resin material, and then machine-processing the resulting machinable ceramic-resin composite article into an instrument body or body parts thereof having such shapes that conventional wood and/or metal materials have been used for the instrument body. When the instrument body is composed of a plurality of body parts, such body parts of the composite material are produced as mentioned above and assembled into the instrument body. The instrument body is then assembled with accessories into an musical instrument.

FIG. 1



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MUSICAL INSTRUMENTS COMPRISING CERAMIC-RESIN COMPOSITES

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to musical instruments such as wind and string instruments comprising ceramic-resin composites.

Prior Art

Hitherto, the bodies of musical instruments have been essentially made from wood, metal or substitutes therefor. Woodwind instruments such as clarinets have been substantially made from wood. Such instruments have defects in that cracking, breakage and the like sometimes develop in the instruments in long-term use thereof and also noises are sometimes produced in strong or large sounds. More specifically, (1) wind instruments comprising wood materials generally produce poor low- and high-pitched tones because wood materials are soft, (2) wind instruments comprising metal materials generally produce poor low-pitched tones and too rich overtones because of low rigidity of metal materials, and (3) string wood instruments generally produce non-uniform tone qualities because of non-uniform vibration of the wood bodies thereof, except for very high-class instruments.

SUMMARY OF THE INVENTION

The main object of the present invention is to provide musical instruments comprising a machinable ceramic-resin composite material wherein the above-mentioned problems are substantially eliminated. Other objects and features of the invention will become apparent from the following description.

Thus, according to the invention, there is provided a musical instrument in which a major portion of the instrument body, where a wood and/or metal material has been used, comprises a machinable ceramic-resin composite material, the machinable ceramic containing substantially continuous micropores and being impregnated with a resin material, the resin material being hardened, and the composite material being machine-processed.

The musical instruments according to the invention in which a major portion of the instrument body, where a wood and/or metal material has been used, comprises a machinable ceramic-resin composite material can be readily produced by a method which comprises

impregnating a machinable ceramic article containing substantially continuous micropores with a liquid resin material and hardening the resin material, and

processing the resulting machinable ceramic-resin composite article into an instrument body or body parts thereof having such shapes that a conventional wood and/or metal material has been used for the instrument body.

When the instrument body is composed of a plurality of body parts, such body parts of the composite material are produced as mentioned above and assembled into the instrument body. The instrument body is then assembled with accessories into a musical instrument.

The musical instruments intended in the invention include, for example, wind instruments such as clarinet, oboe, flute, piccolo and bassoon; string instruments such as violin and cello; percussion musical instruments such as xylophone, etc.

Incidentally, the term "body of the instrument" or "instrument body" means a main body part of the instrument which produces or increases sound tones, for example, a cylindrical tube with or without flaring end of wind instruments; a sound board or box of string instruments; bars of xylophone; etc.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 shows a partially cross-sectional side view of a clarinet body according to the present invention.

FIG.2 shows a CaO-SiO_2-MgO three-component triaxial diagram of the machinable ceramic for use in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The machinable ceramic articles used in the present invention are needed to have substantially continuous micropores, so that the ceramics can be effectively impregnated with resin materials and then hardened. The amount of the micropores in the ceramic, expressed by water absorption capacity (the weight increase of a ceramic article owing to absorbed water when the article is soaked in water for about 24 hours), is usually about 3 to 40 % by weight and preferably about 5 to 25 % by weight. The diameter of the micropores is desired to be considerably small in view of strength and homogeneity. The average diameter is usually not more than 100 microns, preferably not more than 10 microns, more preferably not more than 5 microns, and typically about 5 to 0.1 micron.

The term "machinable ceramic" means ceramics which can be readily subjected to machine processing such as cutting, boring, drilling and grinding without cutting fractures such as chipping, cracking or breaking. The machinability of the ceramics can be defined by the cutting speed thereof by means of a lathe with a tungsten carbide (WC) bit [a bit-moving speed of 0.097 mm/rotation, a bit-notch depth of 2 ~ 4 mm]. The machinable ceramics used in the present invention have a peripheral cutting speed of not lower than 30 m/min., preferably not lower than 50 m/min. and more preferably not lower than 70 meters/minute under the above-mentioned cutting conditions. Incidentally, the ceramic material used in the working examples given below had a machinability (cutting speed) of more than 70 meters/minute without cutting fracture.

The machinable ceramics used in the invention can be produced from a raw material mixture comprising, for example, 20 to 50 parts of CaO, 45 to 70 parts of SiO_2 and 0.1 to 25 parts of MgO on a weight basis by molding the material and then sintering the molded article at a maximum temperature of not lower than 1000°C and generally not higher than 1400°C, preferably not lower than 1100°C, more preferablly not lower than 1150°C, and typically 1200 to 1350°C. The raw material can comprise the above-mentioned $CaO/SiO_2/MgO$ components, based on the total weight of the raw material, in an amount of not less than 60%, preferably not less than 70% and more preferably not less than 80%; and the raw material can contain not more than 20 % of other alkali/alkaline-earth metal oxide components and not more than 20% of other sintering mineral components based on the total weight of the raw material.

The sintered ceramics used as a material of the musical instruments are preferably those having a composition of CaO, SiO_2 and MgO which is defined by the region or area surrounded by points 1, 2, 3, 4, 5, 6 and 7 in FIG. 2. Each of the points 1 ~ 7 in FIG. 2 corresponds to the compositions shown in the following table.

(% by weight)			
Point	CaO	SiO_2	MgO
1	25.7	55.5	18.8
2	35.4	51.6	13.0
3	36.5	51.3	12.2
4	47.4	51.6	1.0
5	45.9	53.1	1.0
6	31.2	61.7	7.1
7	30.2	61.5	8.3

Such sintered ceramics are obtained, for example, by blending CaO, SiO_2 and MgO in such a ratio that the resulting composition may fall within a range of the area surrounded by the points 1, 2, 3, 4, 5, 6 and 7 in FIG. 2, molding the mixture and then firing the resulting molded article, for example, at a temperature higher than 1200°C and not higher than 1350°C. As a raw material of the CaO and SiO_2 can be used natural or synthetic β $CaO \cdot SiO_2$ such as wollastonite and xonotlite. As the MgO material can be used talc, dolomite, magnesium hydroxide, magnesium carbonate and magnesium oxide. These raw materials are well

milled and blended in such a degree that the needle-like or platelet-like crystals are not destroyed, adjusted with respect to water content, shaped in a mold to give a molded article such as blocks, plates or bars having outer configurations larger than the parts or bodies of musical instruments, and then fired.

The above-mentioned sintered ceramics containing CaO-MgO-SiO_2 component systems are very good in cut-machinability. Namely, the β-wollastonite (β $CaO\cdot SiO_2$) contained in the raw material is aggregated crystals of triclinic system which have grown in the form of platelets and has an excellent cut- machinability. However, upon firing the $\beta CaO\cdot SiO_2$ at or higher, monoclinic α-wollastonite is crystallized out of the $\beta CaO\cdot SiO_2$, which results in imparing the cut-machinability thereof. MgO is added to the β-wollastonite in order to raise the transition temperature of the β-wollastonite to α-wollastonite. Thus, the resulting mixture can be fired at the high temperature to obtain good machinability of the β-wollastonite and high mechanical strength. Incidentally, if the amount of MgO is too much, the resulting sintered ceramic becomes too hard and is decreased in the cut-machinability thereof. Thus, sintered ceramics having a composition within a region surrounded by points 1 ~ 7 in FIG. 2 are preferred. However, in the case where the strength required is not so high, it is also possible to use sintered ceramics of $CaO\cdot SiO_2$ component systems sintered at a lower temperature.

The sintered ceramic article which has been formed upon firing into a predetermined shape is degassed in a vacuum apparatus. The degassed sintered ceramic article can be satisfactorily impregnated with a resin by soaking the article in a liquid resin (preferably with pressurization of the liquid resin). The impregnated liquid resin is then hardened by heating or the like.

As the resin can be used, for example, acrylic resins [e.g. polymethyl methacrylate (PMMA)], epoxy resins, saturated or unsaturated polyester resins, silicone resins, and mixtures thereof.

By impregnating the sintered ceramic article with a resin as described above, voids formed in the sintered article are substantially filled with the resin to lose water absorption property and air permeability from the sintered ceramic article, whereby bending strength thereof is increased and non-vibration property thereof is much enhanced.

After impregnation with a resin as mentioned above, the ceramic article can be processed into the body parts of a clarinet body and assembled into the body as shown in FIG.1 by optionally utilizing working machines such as lathes. The inside portions and outer precise portions of the ceramic clarinet body parts can be formed by cutting operations by means of a boring machine and a lathe equipped with super-hard tools and other working machines. Since the sintered ceramic article is excellent in cut-machinability as mentioned above, it can be subjected to processing such as cutting, drilling, grooving, etc. without generating cracks, chipping or the like to give a clarinet body wherein the surface precision and the like of the inner walls of the clarinet are enhanced. Incidentally, the thickness of the machine-processed instrument body is generally smaller than that of a conventional wood body.

Since the sintered ceramic article has such excellent cut-machinability, it can be shaped into musical instruments such as clarinets having excellent precision, which are provided with sound tones unique to sintered ceramics and excellent durability. Moreover, by coloring the resin to be used for the impregnation, the musical instruments can have, for example, a wood-like color or other colors as desired. Thus, it ispossible to give good fashionability to the musical instruments.

The present invention is further explained below by way of working examples.

Example 1:

At first, 100 parts by weight of xonotlite and 10 parts by weight of talc (CaO: 44% by weight, SiO_2: 53% by weight, MgO: 3% by weight) were dry-blended in an Eirich mixer for 5 minutes, and then 16% (outer percentage) by weight of water was added thereto. The resulting mixture was allowed to stand under a sealed state for 24 hours to give a raw mixture material in which the water content thereof has been homogenized. The raw material was placed in a mold for clarinet body parts and molded at 450 Kgf/cm^2. The molded articles were dried at 80 °C for 24 hours and then fired. The firing was carried out in an electric furnace by raising temperature therein from room temperature to 1250 °C at a rate of 10 °C/min., firing the articles at 1250 °C for 60 minutes, and then allowing the articles to cool to room temperature in the furnace.

The resulting sintered articles have a composition of β-wollastonite ($\beta CaO\cdot SiO_2$) in which Mg was dissolved. They had a water absorption capacity of 10.3% and were very excellent in cut-machinability. They had a bending strength of 500 Kg/cm^2.

The sintered articles were sealed in a vacuum apparatus and PMMA was introduced with pressure to impregnate the sintered articles with the PMMA in the vacuum apparatus. The sintered articles thus impregnated therewith had a water absorption capacity and air permeability of almost zero, which proved

that the water absorption property and air permeability thereof had been eliminated.

The materials thus obtained were lathed and bored by means of super-hard tools, and machined along the periphery thereof to give body parts 1, 2, 3 and 4 of a clarinet, and then the body parts were assembled together with a conventional blast-pipe 5 into a clarinet body as shown in FIG. 1, wherein the numeral 7 shows joints of the body and the numeral 6 shows a partially broken cross-sectional portion of the drawing. The clarinet body was equipped with keys and other conventional accessories. The resulting clarinet of the invention produced satisfactory tones.

Example 2:

Flute was produced in the same way as in Example 1. The flute of the present invention was evaluated to be usable as a professional instrument by Mr. J. Hosokawa, a chief flutist of the NHK Orchestra of Japan.

Example 3:

The sound boards and ribs of violin were produced in the same way as in Example 1, and fabricated into a sound box with adhesive. The sound box was then assembled into a violin with other conventional parts and accessories. The resulting violin was evaluated to be usable as a professional instrument by Ms. Y. Sato, a solo violinist in Japan.

Example 4:

The bars of xylophone were produced in the same way as in Example 1. The bars were then assembled into a xylophone with other conventional parts. The resulting xylophone produced satisfactory tones.

Example 5 (Comparative):

The instrument bodies of clarinet and flute were produced from the machinable porous ceramic articles not impregnated with resin, as in Examples 1 and 2 for comparison. The resulting clarinet and flute failed to substantially produce sounds.

Example 6 (Comparative):

The sound boards and ribs of violin were produced from sintered alumina ceramic plates having no continuous pores, and they were fabricated into a sound box with adhesive, as in Example 3. The resulting violin for comparison produced poor sounds and was not usable as an instrument.

Example 7 (Comparative):

It was impossible to produce the instrument bodies of clarinet and flute from sintered alumina articles having no continuous pores, because the alumina articles were too hard and had poor machinability.

The features of the properties, production steps and sound tones with respect to the instruments of the present invention are summarized below. The instrument bodies produced from machinable ceramic-resin composites, in which sintered ceramics having good cut-machinability are impregnated with resins. Due to the properties of the sintered machinable ceramics, the composites are provided with excellent high temperature resistance, mechanical strength, durability without cracks or breaking, etc. The composites are also provided with good non-water absorption, non-air permeability, non-vibration properties, due to the impregnated resins. Moreover, the composites can be machine-processed with good surface precision, and can also have various colors by coloring the resins. As to sound tones, the present instruments comprising the instrument bodies of the composites exhibit good tone qualities combined with dynamic tones due to hard ceramics and wood-like natural tones due to soft resins, as well as exhibit uniform broad tone ranges

without noise sounds in both pitch ranges and dynamic ranges because of uniform constructions and non-vibration properties of the ceramic-resin composites.

Claims

1. A musical instrument, a major portion of which instrument body comprises a machinable ceramic-resin composite material, the machinable ceramic containing substantially continuous micropores and being impregnated with a resin material, the resin material being hardened, and the composite material being machine-processed.

2. The musical instrument according to Claim 1, in which the machinable ceramic to be impregnated with a resin material has a water absorption capacity of 3 to 40 %.

3. The musical instrument according to Claim 1 or 2, in which the machine-processed composite material is substantially employed in the body of the instrument where a wood and/or metal material has been used.

4. The musical instrument according to Claim 1 or 2, in which the instrument is a wind instrument, a string instrument or a xylophone.

5. The musical instrument according to Claim 1 or 2, in which the instrument is a woodwind instrument.

6. The musical instrument according to Claim 1 or 2, in which the instrument is a string instrument.

7. The musical instrument according to any one of Claims 1~6, in which the machinable ceramic is sintered at the maximum temperature of more than 1000 °C and comprises by weight 20~50 parts of CaO, 45~70 parts of SiO_2 and 0.1~25 parts of MgO.

8. The musical instrument according to Claim 7, in which the machinable ceramic comprises by weight not less than 60 % of the $CaO/SiO_2/MgO$ mineral components, not more than 20% of other alkali/alkaline-earth metal oxide components, and not more than 20% of other sintering mineral components.

9. The musical instrument according to any one of Claims 1~8, in which the resin material for the composite is selected from the group consisting of an acrylic resin, an epoxy resin, an unsaturated polyester resin, a saturated polyester resin, a silicone resin, and mixtures thereof.

10. A method for producing a musical instrument a major portion of which instrument body comprises a machinable ceramic-resin composite material; which method comprises
impregnating a machinable ceramic article containing substantially continuous micropores with a liquid resin material and hardening the resin material, and
processing the resulting machinable ceramic-resin composite article into such shapes that conventional wood and/or metal materials have been used for the instrument body.

FIG. 1

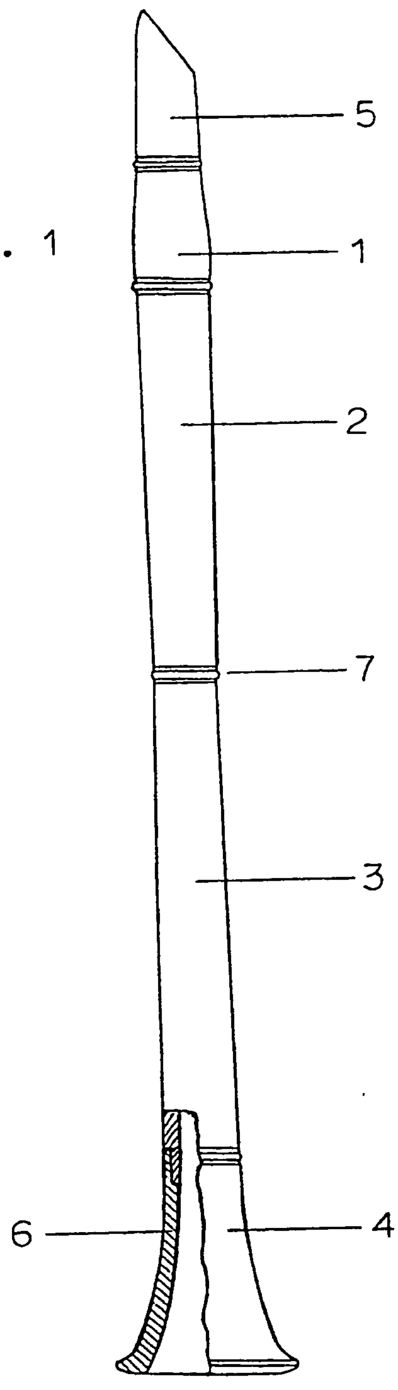

FIG. 2